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Potential influence of physical, psychological and lifestyle factors on the association between television viewing and depressive symptoms: A cross-sectional study

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ABSTRACT

Objective: To investigate the potential influence of physical, psychological, and lifestyle factors on the association between TV-viewing and depressive symptoms among Brazilian adults.

Methods: We used cross-sectional data from the Brazilian National Survey, conducted in 2013 with 60,202 adults (≥18 years). Information regarding exposure (TV-viewing), potential influencing factors (multimorbidity, mobility, self-rated health, tobacco use, alcohol consumption, sugar consumption, and physical activity) as well as elevated depressive symptoms (through PHQ-9 – score > 9) (outcome) was collected via interview-administered questionnaires. Data on covariates were self-reported. Body mass index was estimated through the assessment of body mass and stature. Mediation models were estimated through the Karlson-Holm-Breen method.

Results: Individuals who reported >5h/d of TV viewing showed a higher prevalence of depressive symptoms than those with <5h/d of TV viewing [8.1%(99%CI:7.6%-8.6%) vs 14.2%(99%CI:12.2%-16.6%)]. The association between TV-viewing and depressive symptoms was influenced by tobacco use (Overall:7.22%; men:4.46%, women:8.59%), physical activity (men:3.99%, women:2.28%), mobility (overall:11.31%, men:10.85%, women:11.03%), and multimorbidity (overall:9.11%, men:11.6%4, women:6.03%). Poor self-rated health influenced the association between TV-viewing and elevated depressive symptoms only among men (15.55%). Similarly, the association between >4h/d of TV viewing and depressive symptoms was influenced by tobacco use (men: 6.8%, women: 11.7%), physical activity for women (5.5%), self-rated health for men (14.7%), mobility (men: 8.7%, women: 17.0%), and multimorbidity (men: 9.6%, women: 12.3%).

Conclusions: Tobacco use, physical activity, mobility, multimorbidity, and self-rated health (men) mediate the relationship between high TV-viewing and elevated depressive symptoms. Longitudinal research is required to confirm/refute our data which may also be useful to contribute to public health interventions.

Key words: sedentary behavior; depression; mood.

INTRODUCTION

Major depressive disorder is one of the leading causes of disability worldwide [1]. Subjects with depression have a lower life expectancy, especially due to its correlation with suicide [2] and physical health conditions such as cardiovascular diseases [3]. Beyond the well-established protective association between physical activity and depressive symptoms [4], sedentary behavior, defined as "any waking behavior characterized by an energy expenditure of ≤ 1.5 METs while in a sitting or reclining posture" [5], has been associated with depressive disorders in different cultures and countries with different income levels [6–9].

Although there are different types of sedentary behavior [5], the majority of evidence on the association between sedentary behavior and depressive symptoms is derived from studies that focused on total sitting time [7,10]. However, recent evidence suggests that different sedentary behavior domains can be differently associated with depressive symptoms [11]. For example, mentally-active sedentary activities such as working and sitting during a meeting appear to be protective of depressive symptoms, while mentally-passive sedentary activities (e.g. TV-viewing, listening to music) seem to be risk factors for elevated depressive symptoms [11]. A prospective cohort study in Sweden among 24,000 adults suggested that replacing 30 minutes of mentally passive with mentally active sedentary behavior may be associated with a reduced risk of future clinician diagnosed depression [12]. Although the field of sedentary behavior and specifically research demonstrating the potential deleterious impact of passive sedentary behavior is relatively new, TV-viewing is considered a predominantly passive sedentary behavior that has been associated with depressive symptoms

[13]. However, to date, there is a paucity of evidence, particularly in non-high income countries, on the underpinning factors that may influence the relationship between TV-viewing and depressive symptoms.

A previous study that investigated the association between high sitting time and depressive symptoms found that mobility, pain, cognition, sleep quality, vision, anxiety, and disability influenced this association [14]. However, TV-viewing, a predominantly mentally-passive sedentary behavior, has specifically been associated with several comorbidities such as multimorbidity [15–17], mobility [14], obesity [14], and self-rated health [18], as well as lifestyle factors like alcohol use and tobacco use [19], which are also associated with depressive symptoms.

The "direct" association of sedentary behaviors with depressive symptoms may be explained by intrinsic biological mechanisms such as increased inflammation [20] as well as a lack of socialization [21]. Moreover, TV-viewing has been found to be associated with the co-occurrence of several other lifestyle factors such as alcohol ingestion, tobacco use, dietary patterns [22], presence of other chronic diseases [17], multimorbidity [16], mobility [23], and psychological factors such as lower self-rated health, which are also associated with depressive symptoms. However, there is a paucity of research that has considered how these lifestyle and psychological factors could potentially influence the association between TV-viewing and depressive symptoms.

Thus, identifying potential factors that may influence and indirectly explain the association between TV-viewing and depressive symptoms could contribute to understanding the nexus and help to support a broader range of interventions to improve the negative influence of TV-viewing on mental health. Therefore, the primary aim of the present paper was to investigate the potential influence of

physical, psychological, and lifestyle factors on the association between TV-viewing and depressive symptoms among Brazilian adults.

Methods

Sample

In the present study, we used data collected from the Brazilian National Health Survey (PNS in Portuguese) [24], a cross-sectional epidemiological study, conducted with a national representative sample of adults (18 to 100 years old) during 2013. The sampling process was conducted in clusters. First, census tracts were randomly selected; next, households were randomly selected; and finally, in the households, one adult was randomly selected. The minimum sample size per federal unit (n = 27) was 1,800 households, with a total of 64,348 households. For this investigation, the sample consisted of 60,202 adults with complete data for all variables, except for the analyses involving body mass index (BMI) that used fewer subjects (n=59,402) due to missing data. Sampling weights were created considering the weight of the household, adjusted for non-response by sex and total population by sex and age, and counting the number per household. Thus, sampling weight was accounted for in all analyses. More detailed descriptions of the sample process and weighting have been previously published [24]. All variables were collected through household interviews. The Brazil National Council of Ethics in Research approved all procedures according to the Helsinki declaration.

Television time

TV-watching was estimated through the question: “How many hours a day do you usually spend watching TV?” Responses were: a) Less than 1h; b) More than 1h, but less than 2h; c) More than 2h, but less than 3h; d) More than 3h, but less than 4h; e) More than 4h, but less than 5h; f) More than 5h, but less than 6h; g) More than 6h; h) I do not watch TV. We dichotomized this indicator as: 0 = 4.99h/day or less; and 1 = 5h or more, based on a previous study that found a substantial increase in elevated depressive symptoms among subjects with more than 5h/day of TV-viewing [13,25]. Furthermore, for secondary analyses, we also adopted the conventional 2h/day and 4h/day cut-off points for TV-viewing [26–28].

Depressive symptoms

The outcome of this study was positive screening for depression measured using the Patient Health Questionnaire-9 (PHQ-9) [29], which evaluated the frequency of depressive symptoms (depressed mood, anhedonia, trouble sleeping, tiredness or lack of energy, change of appetite or weight, feeling of guilt or uselessness, trouble concentrating, feeling slow or agitated, and having recurrent thoughts about death or suicidal ideation), over the two weeks prior to data collection. Each of the nine questions in the PHQ-9 has four possible answers rated on a Likert-scale, “Not at all”, which has a value of 0; “Several days”, with a value of 1; “More than half the days”, with a value of 2; and “Nearly every day”, with a value of 3. The algorithm of the test was used to identify individuals at a higher risk of a major depressive episode (MDE), with the sum of the values > 9 adopted as the cut-point for denoting higher depression symptoms [30,31]. This instrument has already been validated for Brazilian adults [32]. Moreover, the questionnaire presented a good Cronbach’s alpha value (0.836) in the present sample.

Lifestyle factors

Leisure-time physical activity was assessed through three subjective questions. First, the subjects were asked if they had practiced any sport or physical activity in the previous three months with the question: "Have you practiced any sport and/or activity in the last three months?" The possible answers were: "Yes" and "No". Next, the frequency of practice was established with the question: "How many days a week do you practice sports or physical activity?" Finally, the participants were asked a question concerning the length of practice: "In general, on the day that you practice sports and/or physical activity, how many hours/minutes does it take?" We classified physical activity into active or inactive using the World Health Organization recommendation of meeting or not meeting the 150 min/week activity level, respectively [33].

Tobacco use was evaluated through the question "Do you use any tobacco product?"; answers were "yes, daily", "yes, but not daily", and "no". We considered those who answered "yes, daily" and "yes, but not daily" as having exposure. Participants were asked on how many days per week they usually consumed alcohol; with the classification of: 1) Non alcohol consumers or non-regular alcohol consumers (0-1 times per week); 2) Alcohol consumers (at least 2 times per week). With regards to sugary foods consumption, participants reported on how many days per week they consumed sweet foodstuffs (e.g. cake, sweets, chocolate, candies, or biscuits). We adopted the cut-off point of at least 3 days of sugary food consumption for the analysis.

Physical and psychological factors

Body mass index was calculated using measures of body mass (digital scale) and stature (portable stadiometer) and classified according to well recognized cutoff points (Overweight: BMI between 25.0 kg/m^2 and 29.9 kg/m^2; Obese: ≥30 kg/m^2) [34]. Self-rated health (SRH) was assessed through the following question "In general, how do you consider your health?" Responses were on a 5-point Likert-type scale: 1 = very bad, 2 = bad, 3 = regular, 4 = good, and 5 = excellent. Participants were considered at risk of poor SRH when they answered "very bad" or "bad". Mobility was assessed through the question "In general, what degree of difficulty do you have to move yourself?" Answers were: "none", "low difficulty", "medium difficulty", "high difficulty", and "not capable of moving myself". We considered at risk those who answered at least "low difficulty". A total of seven chronic conditions were recorded through interviews. Cancer was evaluated through a question asking if the subject had already a medical diagnosis of any type of cancer. Subjects that answered "yes" were considered as survivors and/or with cancer. Dyslipidemia, type 2 diabetes, hypertension, heart disease, stroke, and pulmonary disease were assessed by asking participants if a physician had ever diagnosed them as having the outcomes. Response options were binary (no/yes). People were classified as having physical multimorbidity if they had >2 chronic conditions in line with previous research [15].

Covariates

Chronological age, as a continuous variable, was used as a covariate. In addition, skin color was self-reported and dichotomized as white and not white. Educational status was collected through the question: "What is your highest academic qualification?" From the responses, three categories (1 = no academic degree; 2 =

at least high school; and 3 = at least college) were created as an indicator of socioeconomic status. Moreover, employment status was assessed through a question asking if the subject had a remunerated job in the previous month, with a 'yes' or 'no' response option adopted as the covariate.

Statistical procedures

Descriptive statistics, with frequencies as well as their respective 99% confidence intervals were used to describe the sample. Non-crossed 99% confidence intervals were used to compare groups [35]. Mediation analysis was conducted to assess the influence of behavioral, psychological, and physical factors on the association between elevated TV-viewing and depressive symptoms. The Karlson Holm Breen method was used for the mediation [36]. This method is applied in logistic regression models and decomposes the total effect (without the mediator effect) of a variable into direct (the direct association of elevated TV-viewing and depressive symptoms, accounting for potential mediator effect) and indirect effects (the mediation effect). This estimation also provides the percentage of explanation by the mediator (mediated percentage), when the indirect effect is significant. As this method uses logit estimations, it is also widely used in cross-sectional research [14,37]. We adopted 95% confidence intervals to describe mediation coefficients due the software limitation in producing 99% confidence intervals. The theoretical model that underpins the exploration of factors that may influence the association between TV viewing and depressive symptoms for the analysis is presented in **Figure 1**. All analyses were conducted in STATA 15.1, adopting $p < 0.01$.

RESULTS

The final sample consisted of 60,202 adults (34,282 women), with the exception of the BMI analysis that included 59,402 adults (33,482 women) due to missing data. The characteristics of the sample according to the level of depressive symptoms are presented in **Table 1**. The factors that appeared to be associated with higher depressive symptoms included spending more than 5 h/d TV-viewing, female sex, lower educational status, alcohol drinking, tobacco use, overweight/obese, dyslipidemia, diabetes, hypertension, heart disease, stroke, cancer, chronic obstructive pulmonary diseases, multimorbidity, lower mobility, and poor self-rated health.

Models of lifestyle influential factors on the association between elevated TV-viewing (using the cut-off point of 5h/day) and depressive symptoms are presented in **Table 2**. The only consistent behavioral factor that appeared to influence the association was tobacco use. Tobacco use explained about 7% of the positive association between TV-viewing and depressive symptoms for the entire sample. Tobacco use explained 4.5% and 8.6% of the association between TV-viewing and depressive symptoms for men and women respectively. Alcohol consumption and physical activity did not explain the association between TV-viewing and depressive symptoms.

Models of physical and psychological factors influencing the association between elevated TV-viewing (using the cut-off point of 5h/day) and depressive symptoms are presented in **Table 3**. Self-rated health explained approximately 15.6% of the association between TV-viewing and depressive symptoms among men. However, the relationship among women was not significant. Mobility

limitations explained the association between TV-viewing and depressive symptoms in the overall sample (11.3%), men (10.9%), and women (11.0%). Similarly, multimorbidity also partially explained the association in men (11.6%) as well as in the overall sample (9.1%).

Models of the influential factors for the association between TV-viewing and depressive symptoms using the cut-off point of 2h/day are presented in **Supplementary table A**. Using the cut-off point of 2h/day, elevated TV-viewing was not associated with elevated depressive symptoms.

Models of the influential factors for the association between TV-viewing and depressive symptoms using the cut-off point of 4h/day are presented in **Supplementary table B.** Similar to the results using the cut-off point of 5h/day, we found that tobacco use explained the association between TV-viewing and depressive symptoms (overall: 10.8%, men: 6.8%, women: 11.7%). Concerning physical and psychological potential influential factors, mobility (women: 17.0%) and multimorbidity (men: 9.6%, women: 12.3%) explained the association between TV-viewing and depressive symptoms.

DISCUSSION

The aim of our study was to investigate the association between high TV-viewing and depressive symptoms among Brazilian adults and explore potential factors that influence this association, including physical, psychological, and lifestyle factors. Our data suggest that tobacco use, alcohol consumption, physical activity, self-hated health, mobility, and multimorbidity explain part of the association

between more than 5h/day and 4h/day of TV-viewing and elevated depressive symptoms.

Given this background, our study investigated specifically the association between TV-viewing (typically regarded as a mentally passive sedentary behavior) and depressive symptoms [6,13] and the factors that may influence this relationship. We found that when using the cut-off points of 4h/day and 5h/day, TV-viewing was associated with higher depressive symptoms, however, using the 2h/day cut-off point, this association was not significant. This finding could be due to a potential dose-response association between TV-viewing and depressive symptoms, in which, previous studies also found that 2h/day was not sufficient for depression screening [13,25]. TV-watching for 2h/day is prevalent and common in the population, however, which may explain why this "dose" does not correlate easily with a positive screening for depression.

Our findings indicated that mobility limitations and multimorbidity appear to be influential in the association between elevated TV-viewing and depressive symptoms. These results indicate that elevated TV-viewing is related to mobility limitations and multimorbidity, which, in turn, could increase the likelihood of depressive symptoms. However, the relationship between mobility limitations/multimorbidity and elevated TV-viewing might also be bidirectional [15]. Chronic conditions may naturally lead to greater TV-viewing through the restriction of physical mobility [23], whilst higher TV-viewing may increase the likelihood of chronic conditions such as hypertension and diabetes [17,23]. These associations should be confirmed in longitudinal designs. In any case, our findings highlight factors that are associated with TV-viewing and could also increase the likelihood of elevated depressive symptoms.

We also found that physical activity and tobacco use are potential lifestyle factors that may influence the association between TV-viewing and depressive symptoms. While this could represent an aggregation of negative health behaviors, TV-viewing can in fact lead to the adoption of other risk behaviors that are associated with depressive symptoms [19]. For instance, engagement in higher TV-viewing can predispose to greater exposure to tobacco use scenes from television programs, which has been associated with tobacco use initiation [38,39].

Concerning physical activity, a previous study has shown a possible convergence of its influence on the association between sitting time and depressive symptoms [40]. Thus, the mechanisms underlying the association of both sitting time and physical inactivity with depressive symptoms may be underpinned via changes in inflammation. A recent randomized control trial of enforced sedentary behavior among healthy adults found that as sedentary behavior increased mood symptoms decreased and this was accompanied by an increased inflammatory response [20]. It is suggested that people with major depression have increased inflammation profiles [41], while higher sitting time is associated with a higher inflammatory profile [20,42]. This could be one potential mechanism underpinning the observed relationship. However, since TV viewing represents a specific manifestation of sitting time, other factors could account for the relationship with depression and the potential mediation effect of physical activity, such as social isolation and loneliness [43].

Although there is not much prior research in this field, the current study may present some potential practical implications for interventions aimed at mitigating the negative influence of high TV-viewing on depressive symptoms. For example, wider lifestyle interventions could be warranted for depression

prevention in people who spend a lot of time in front of a television. In addition, as part of public health campaigns to improve mental health, population sub-groups with poor self-rated health, poor mobility, and multimorbidity deserve special attention to ensure they minimize TV viewing to less than 5h/d. Furthermore, as higher TV-viewing was associated with depressive symptoms, campaigns focusing on reducing excessive TV-viewing, the adherence to depression treatments, and the reduction in possible influential factors such as tobacco and alcohol use, as well as stimulating physical activity practice could be fruitful. As an example, a previous study found promising results concerning the use of television advertisements for reducing tobacco use in the general population [44]. However, future longitudinal studies are needed to investigate the evidence of directional causality between TV-viewing, potential influential factors, and depressive symptoms. These studies should also include a wider range of mediators and confounders in order to better clarify the strength of each mediator. Advances in this field could provide important information for health policies aimed at reducing the current burden of depression worldwide.

Our findings should be interpreted in the light of possible limitations. We did not adjust for other potential confounders such as social support, income, isolation, loneliness, and a family history of depression which could have impacted the direction of our findings. Moreover, TV-viewing is only one type of "mentally-passive" sedentary behavior and there are other types (e.g. listening to music) that also negatively impact on depressive symptoms. Diagnoses of chronic diseases by a physician were also self-reported and only one domain of physical activity (leisure-time) was explored. Finally, due to the cross-sectional design, directionality should not be inferred. However, we used a valid questionnaire for

depressive symptom screening [30,32] and provided data of the association between TV-viewing, several potential influential factors, and depressive symptoms, using a large representative sample from an understudied middle-income country.

In conclusion, TV-viewing is associated with elevated depressive symptoms among Brazilian adults. This association is partially explained by unhealthy lifestyle, poor self-rated health, poor mobility, and multimorbidity. This evidence can contribute to public health interventions to control and prevent mental health problems among Brazilian adults.

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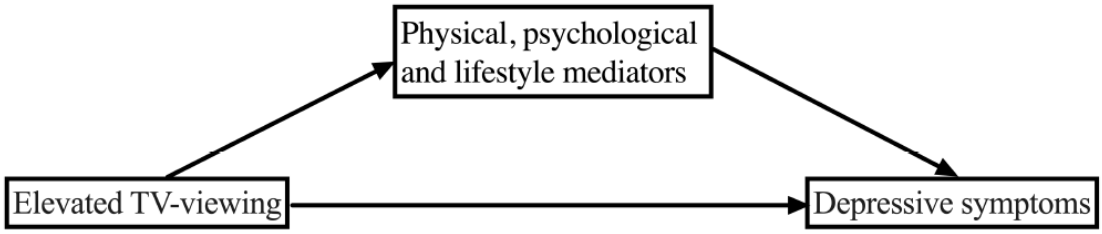

Figure 1. Theoretical model.

Table 1. Characteristics of the sample and prevalence of lower and higher depressive symptoms.

		n	Lower depressive symptoms % (99%CI)	Higher depressive symptoms % (99%CI)
Sex	Male	25,920	49.2 (48.2-50.2)	28.6 (25.7-31.6)
	Female	34,282	50.8 (49.8-51.8)	71.4 (68.3-74.3)
Age	18-39	28,590	48.0 (47.0-49.0)	38.0 (35.1-41.0)
	40-59	20,435	34.1 (33.1-35.0)	40.3 (37.3-43.5)
	60 +	11,177	17.9 (17.2-18.7)	21.6 (19.2-24.3)
Educational status	Up to high school	51,606	85.7 (85.0-86.3)	89.7 (87.6-91.6)
	College or more	8,596	14.3 (13.7-15.0)	10.3 (8.4-12.4)
Employment status	No	33,990	59.2 (58.2-60.1)	43.8 (40.7-46.9)
	Yes	26,212	40.8 (40.0-41.8)	56.2 (53.1-59.3)
Skin color	White	24,106	47.6 (46.7-48.6)	45.3 (42.2-48.4)
	Other	36,096	52.4 (51.4-53.3)	54.7 (51.6-57.8)
Alcohol drinking	0-1 times/week	53,119	86.5 (85.8-87.2)	90.1 (88.1-91.9)
	≥2 times/week	7,083	13.5 (12.8-14.2)	9.9 (8.1-11.9)
Tobacco use	No	51,473	85.7 (84.9-86.3)	79.7 (77.0-82.1)
	Yes	8,729	14.3 (13.7-15.1)	20.3 (17.9-23.0)
Sugary foods ingestion	0-2 times/week	39,427	61.8 (60.9-62.8)	62.5 (59.6-65.7)
	≥3 times/week	20,775	38.1 (37.2-39.1)	37.5 (34.3-40.4)
Body mass index	Eutrophic	25,446	43.4 (42.5-44.4)	39.0 (36.0-42.0)
	Overweight/Obese	33,956	56.6 (55.6-57.5)	61.0 (58.0-64.0)
TV-viewing	0-4.99 h/day	54,850	91.9 (91.4-92.4)	85.8 (83.4-87.8)
	≥ 5 h/day	5,352	8.1 (7.6-8.6)	14.2 (12.2-16.6)
Physical activity	Inactive	48,990	80.0 (79.2-80.8)	87.3 (85.0-89.2)
	Active	11,212	20.0 (19.2-20.8)	12.8 (10.8-15.0)
Dyslipidemia	No	52,903	88.3 (87.6-88.9)	76.9 (74.0-79.5)
	Yes	7,299	11.7 (11.1-12.4)	23.1 (20.5-26.0)
Diabetes	No	56,364	93.9 (93.5-94.4)	88.1 (85.9-90.0)
	Yes	3,838	6.1 (5.6-6.5)	11.9 (10.0-14.1)
Hypertension	No	46,875	78.6 (77.8-79.4)	61.7 (58.6-64.7)
	Yes	13,327	21.4 (20.6-22.2)	38.3 (35.3-41.4)
Heart disease	No	57,969	96.5 (96.1-96.9)	87.4 (84.8-89.5)
	Yes	2,233	3.5 (3.1-3.9)	12.6 (10.5-15.2)
Stroke	No	59,236	98.7 (98.5-98.9)	95.3 (93.8-96.5)
	Yes	966	1.3 (1.1-1.5)	4.7 (3.5-6.2)
Cancer	No	59,268	98.3 (98.0-98.5)	96.7 (95.4-97.6)
	Yes	934	1.7 (1.5-2.0)	3.3 (2.4-4.6)
COPD	No	59,179	98.5 (98.2-98.7)	95.1 (93.6-96.3)
	Yes	1,023	1.5 (1.3-1.8)	4.9 (3.7-6.4)
Multimorbidity	No	53,084	88.7 (88.1-89.4)	70.9 (67.9-73.8)
	Yes	7,118	11.2 (10.6-11.9)	29.1 (26.2-32.1)
Mobility	Good	54,507	91.9 (91.3-92.4)	72.9 (69.8-75.4)
	Poor	5,695	8.1 (7.6-8.7)	27.1 (24.6-30.2)
Self-rated health	Good	39,141	69.3 (68.3-70.1)	28.3 (25.6-31.2)
	Poor	21,061	30.8 (29.9-31.7)	71.7 (68.8-74.4)

Note. CI, confidence interval; COPD, Chronic Obstructive Pulmonary Disease. *p<0.05.

Table 2. Cross sectional models for the role of lifestyle potential mediators using ≥5h/day of TV-viewing as cut-off point.

Mediator	Sex	Total effect	p	Direct effect	P	Indirect Effect	P	%mediator
Sugary food consumption	Overall	1.62 (1.40-1.88)	<0.001	1.62 (1.39-1.88)	<0.001	1.00 (0.99-1.01)	0.514	N/A
	Men	1.99 (1.49-2.67)	<0.001	1.99 (1.49-2.67)	<0.001	1.00 (0.99-1.00)	0.851	N/A
	Women	1.51 (1.27-1.78)	<0.001	1.50 (1.27-1.78)	<0.001	1.00 (0.99-1.01)	0.409	N/A
Tobacco use	Overall	1.62 (1.40-1.88)	<0.001	1.57 (1.35-1.81)	<0.001	1.04 (1.02-1.05)	<0.001	7.22
	Men	1.99 (1.49-2.67)	<0.001	1.93 (1.44-2.59)	<0.001	1.03 (1.01-1.05)	0.007	4.46
	Women	1.50 (1.27-1.77)	<0.001	1.45 (1.23-1.71)	<0.001	1.04 (1.02-1.05)	<0.001	8.59
Alcohol drinking	Overall	1.66 (1.44-1.92)	<0.001	1.68 (1.46-1.94)	<0.001	0.99 (0.98-0.99)	0.814	N/A
	Men	1.99 (1.49-2.67)	<0.001	1.98 (1.48-2.64)	<0.001	1.01 (0.99-1.02)	0.395	N/A
	Women	1.51 (1.27-1.78)	<0.001	1.51 (1.28-1.79)	<0.001	1.00 (0.98-1.01)	0.522	N/A
Physical activity	Overall	1.62 (1.40-1.88)	<0.001	1.62 (1.40-1.88)	<0.001	1.00 (0.99-1.00)	0.496	N/A
	Men	2.01 (1.51-2.69)	<0.001	1.96 (1.47-2.62)	<0.001	1.03 (1.01-1.05)	0.023	N/A
	Women	1.51 (1.27-1.78)	<0.001	1.52 (1.29-1.80)	<0.001	0.99 (0.98-0.99)	0.025	N/A

Note. Values are presented in odds ratio (95%CI). Adjusted by sex (overall analysis), age group, race, employment status, and educational status. % of mediation was only calculated for significant indirect effect.

Table 3. Cross sectional models for the role of physical and psychological potential mediators using ≥5h/day of TV-viewing as cut-off point.

Mediator	Sex	Total effect	p	Direct effect	P	Indirect Effect	P	%mediator
Body mass index	Overall	1.62 (1.40-1.88)	<0.001	1.62 (1.39-1.88)	<0.001	1.00 (0.99-1.01)	0.130	N/A
	Men	1.99 (1.49-2.67)	<0.001	1.99 (1.49-2.67)	<0.001	1.00 (0.99-1.00)	0.800	N/A
	Women	1.51 (1.27-1.79)	<0.001	1.50 (1.26-1.78)	<0.001	1.01 (1.00-1.01)	0.082	N/A
Self-rated health	Overall	1.68 (1.45-1.96)	<0.001	1.63 (1.40-1.89)	<0.001	1.03 (0.99-1.08)	0.088	N/A
	Men	2.03 (1.49-2.76)	<0.001	1.82 (1.33-2.47)	<0.001	1.11 (1.04-1.20)	0.003	15.55
	Women	1.54 (1.30-1.83)	<0.001	1.54 (1.30-1.83)	<0.001	0.99 (0.95-1.04)	0.894	N/A
Mobility	Overall	1.62 (1.39-1.89)	<0.001	1.53 (1.31-1.79)	<0.001	1.06 (1.03-1.08)	<0.001	11.31
	Men	1.96 (1.45-2.66)	<0.001	1.82 (1.35-2.47)	<0.001	1.08 (1.03-1.12)	<0.001	10.85
	Women	1.50 (1.26-1.79)	<0.001	1.44 (1.20-1.72)	<0.001	1.05 (1.02-1.08)	<0.001	11.03
Multimorbidity	Overall	1.63 (1.40-1.89)	<0.001	1.56 (1.34-1.81)	<0.001	1.05 (1.03-1.07)	<0.001	9.11
	Men	1.96 (1.46-1.62)	<0.001	1.81 (1.35-2.42)	<0.001	1.08 (1.04-1.13)	<0.001	11.64
	Women	1.51 (1.28-1.80)	<0.001	1.48 (1.24-1.75)	<0.001	1.03 (1.01-1.05)	0.026	N/A

Note. Values are presented in odds ratio (95%CI). Adjusted by sex (overall analysis), age group, race, employment status, and educational status. % of mediation was only calculated for significant indirect effect.

Supplementary Table A. Cross-sectional models for role of potential influential factors using ≥2h/day of TV-viewing as cutoff point.

Mediator	Sex	Total effect	p	Direct effect	P	Indirect Effect	P	%mediator
Lifestyle potential mediators								
Sugary foods consumption	Overall	0.92 (0.83-1.02)	0.100	0.92 (0.83-1.01)	0.093	1.01 (1.00-1.01)	0.322	N/A
	Men	0.89 (0.73-1.08)	0.252	0.89 (0.73-1.08)	0.253	1.00 (0.99-1.01)	0.909	N/A
	Women	0.94 (0.84-1.06)	0.322	0.94 (0.84-1.06)	0.294	1.01 (1.00-1.01)	0.278	N/A
Tobacco use	Overall	0.92 (0.83-1.02)	0.098	0.90 (0.82-0.99)	0.047	1.02 (1.01-1.02)	<0.001	19.96
	Men	0.89 (0.73-1.09)	0.257	0.88 (0.72-1.07)	0.198	1.01 (1.01-1.02)	0.005	13.69
	Women	0.94 (0.84-1.06)	0.293	0.93 (0.82-1.04)	0.189	1.02 (1.01-1.02)	<0.001	24.64
Alcohol drinking	Overall	0.92 (0.83-1.02)	0.102	0.92 (0.83-1.01)	0.095	1.00 (0.99-1.01)	0.496	N/A
	Men	0.89 (0.73-1.08)	0.250	0.89 (0.73-1.08)	0.228	1.01 (0.99-1.01)	0.287	N/A
	Women	0.94 (0.84-1.06)	0.323	0.94 (0.84-1.06)	0.327	1.00 (0.99-1.00)	0.810	N/A
Physical activity	Overall	0.92 (0.83-1.02)	0.109	0.91 (0.82-1.01)	0.069	1.01 (1.00-1.02)	0.001	13.44
	Men	0.90 (0.74-1.09)	0.270	0.88 (0.73-1.07)	0.213	1.01 (1.01-1.03)	0.047	N/A
	Women	0.94 (0.84-1.06)	0.337	0.94 (0.83-1.05)	0.261	1.01 (1.01-1.02)	0.010	N/A
Physical and psychological potential mediators								
Body mass index	Overall	0.92 (0.83-1.01)	0.094	0.91 (0.83-1.01)	0.079	1.01 (1.00-1.01)	0.025	N/A
	Men	0.89 (0.73-1.08)	0.252	0.89 (0.73-1.09)	0.255	1.00 (0.99-1.00)	0.741	N/A
	Women	0.94 (0.84-1.06)	0.312	0.93 (0.83-1.05)	0.248	1.01 (1.00-1.01)	0.007	14.05
Self-rated health	Overall	0.92 (0.83-1.02)	0.109	0.93 (0.84-1.04)	0.196	0.98 (0.96-1.01)	0.139	N/A
	Men	0.89 (0.73-1.08)	0.245	0.89 (0.73-1.09)	0.269	0.99 (0.96-1.03)	0.750	N/A
	Women	0.94 (0.83-1.06)	0.300	0.96 (0.85-1.08)	0.505	0.98 (0.95-1.01)	0.111	N/A
Mobility	Overall	0.92 (0.83-1.01)	0.089	0.91 (0.83-1.01)	0.079	1.00 (0.99-1.01)	0.616	N/A
	Men	0.89 (0.73-1.08)	0.241	0.89 (0.73-1.08)	0.228	1.00 (0.99-1.02)	0.698	N/A
	Women	0.94 (0.83-1.05)	0.286	0.93 (0.83-1.05)	0.261	1.00 (0.99-1.02)	0.645	N/A
Multimorbidity	Overall	0.92 (0.83-1.01)	0.090	0.91 (0.82-1.00)	0.060	1.01 (1.00-1.02)	0.063	N/A
	Men	0.88 (0.72-1.07)	0.199	0.87 (0.71-1.05)	0.152	1.01 (1.00-1.03)	0.061	N/A
	Women	0.94 (0.84-1.06)	0.303	0.94 (0.83-1.05)	0.276	1.00 (0.99-1.02)	0.598	N/A

Note. Values are presented in odds ratio (95%CI). Adjusted by sex (overall analysis), age group, race, employment status and educational pattern. % of mediation was only calculated for significant indirect effect.

Supplementary Table B. Cross-sectional models for role of potential influential factors using ≥4h/day of TV-viewing as cutoff point.

Mediator	Sex	Total effect	p	Direct effect	P	Indirect Effect	P	%mediator
Lifestyle potential mediators								
Sugary foods consumption	Overall	1.31 (1.16-1.48)	<0.001	1.31 (1.16-1.48)	<0.001	1.00 (0.99-1.01)	0.466	N/A
	Men	1.54 (1.21-1.96)	<0.001	1.54 (1.21-1.96)	<0.001	1.00 (0.99-1.01)	0.806	N/A
	Women	1.23 (1.07-1.42)	0.003	1.23 (1.07-1.42)	0.004	1.00 (0.99-1.01)	0.362	N/A
Tobacco use	Overall	1.31 (1.16-1.48)	<0.001	1.27 (1.13-1.44)	<0.001	1.03 (1.02-1.04)	<0.001	10.77
	Men	1.54 (1.21-1.96)	<0.001	1.49 (1.17-1.90)	0.001	1.03 (1.01-1.05)	0.004	6.84
	Women	1.23 (1.07-1.42)	0.003	1.20 (1.05-1.38)	0.010	1.02 (1.01-1.04)	<0.001	11.72
Alcohol drinking	Overall	1.31 (1.16-1.48)	<0.001	1.31 (1.16-1.48)	<0.001	1.00 (0.99-1.01)	0.704	N/A
	Men	1.54 (1.21-1.95)	<0.001	1.53 (1.20-1.94)	0.001	1.01 (0.99-1.03)	0.401	N/A
	Women	1.23 (1.07-1.42)	0.003	1.24 (1.08-1.42)	0.003	1.00 (0.99-1.01)	0.639	N/A
Physical activity	Overall	1.31 (1.16-1.48)	<0.001	1.29 (1.15-1.46)	<0.001	1.01 (1.01-1.02)	0.001	4.94
	Men	1.55 (1.22-1.97)	<0.001	1.52 (1.20-1.94)	0.001	1.01 (0.99-1.03)	0.125	N/A
	Women	1.24 (1.08-1.42)	0.003	1.22 (1.06-1.41)	0.005	1.02 (1.00-1.02)	0.011	N/A
Physical and psychological potential mediators								
Body mass index	Overall	1.31 (1.16-1.49)	<0.001	1.31 (1.16-1.48)	<0.001	1.00 (0.99-1.01)	0.084	N/A
	Men	1.54 (1.21-1.95)	<0.001	1.54 (1.21-1.85)	<0.001	1.00 (0.99-1.01)	0.872	N/A
	Women	1.24 (1.07-1.43)	0.003	1.23 (1.07-1.42)	0.005	1.01 (1.00-1.02)	0.019	N/A
Self-rated health	Overall	1.34 (1.18-1.52)	<0.001	1.31 (1.15-1.48)	<0.001	1.02 (0.99-1.05)	0.129	N/A
	Men	1.56 (1.21-2.00)	0.001	1.46 (1.13-1.87)	0.003	1.07 (1.01-1.13)	0.018	N/A
	Women	1.25 (1.08-1.44)	0.003	1.24 (1.08-1.44)	0.003	1.01 (0.96-1.04)	0.972	N/A
Mobility	Overall	1.30 (1.14-1.47)	<0.001	1.25 (1.10-1.42)	<0.001	1.04 (1.02-1.05)	<0.001	13.32
	Men	1.52 (1.19-1.95)	0.001	1.46 (1.14-1.88)	0.003	1.04 (1.01-1.07)	0.011	N/A
	Women	1.23 (1.06-1.42)	0.006	1.18 (1.02-1.37)	0.024	1.04 (1.01-1.06)	0.003	17.03
Multimorbidity	Overall	1.31 (1.15-1.48)	<0.001	1.27 (1.12-1.43)	<0.001	1.03 (1.02-1.05)	<0.001	11.81
	Men	1.52 (1.20-1.93)	0.001	1.46 (1.15-1.86)	0.002	1.04 (1.01-1.07)	0.002	9.58
	Women	1.23 (1.07-1.42)	0.004	1.20 (1.04-1.38)	0.012	1.03 (1.01-1.05)	0.007	12.32

Note. Values are presented in odds ratio (95%CI). Adjusted by sex (overall analysis), age group, race, employment status and educational pattern. % of mediation was only calculated for significant indirect effect.